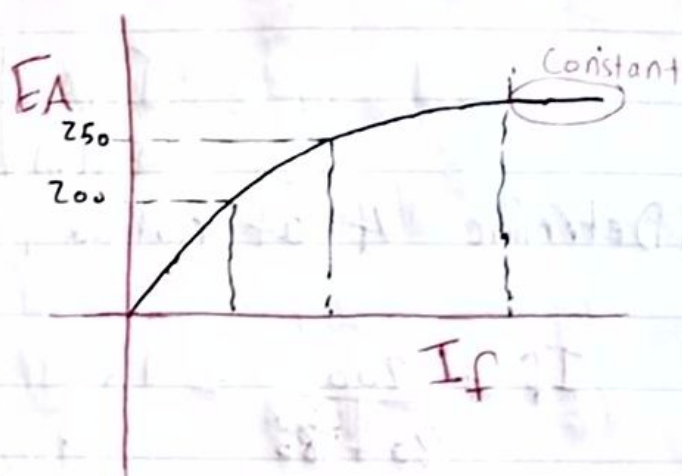
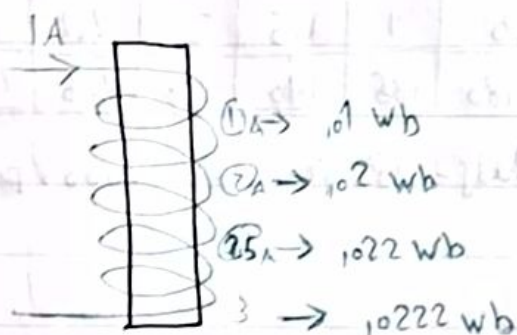


$$E_A = K \phi \omega$$



Ex: $E_{A1} = 100 \text{ V}$, $I_f = 1 \text{ A}$, $n = 1000 \text{ rpm}$
 $E_{A2} = ??$, $I_f = 1 \text{ A}$, $n = 1500 \text{ rpm}$

افهم 2 $E_{A1} = K \phi \times n_1 \times \frac{2\pi}{60} = 100$

$E_{A2} = K \phi \times n_2 \times \frac{2\pi}{60} = ??$

$$\frac{100}{E_{A2}} = \frac{n_1}{n_2} \Rightarrow E_{A2} = \frac{100 \times 1500}{1000} = 150 \text{ V}$$

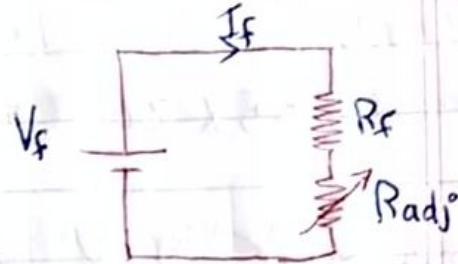
E_A , R_{adj} , n يكون متغيرين
 معاً وينطق الثالث

Shunt $\xrightarrow{\text{also}}$ Parallel

* flux $\left\{ \begin{array}{l} \text{Permanent magnet} \rightarrow \text{uncontrolled} \\ \text{elector magnet} \rightarrow \text{controlled} \end{array} \right.$



* field circuit %



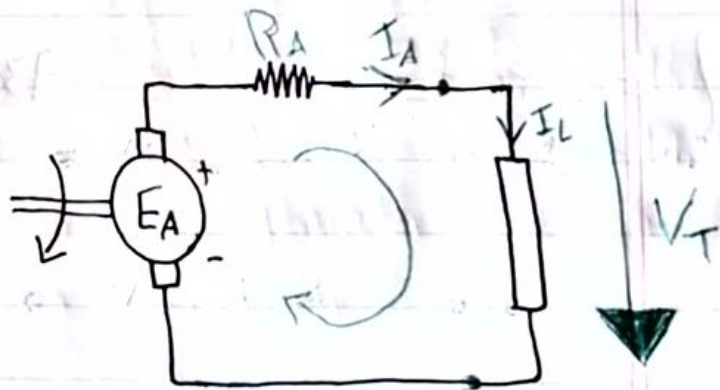
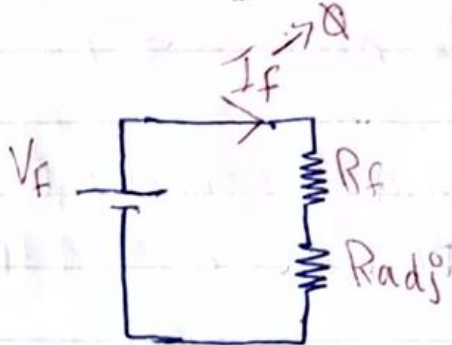
$$\Phi = \frac{\text{MMF}}{R} = \frac{NI}{R}$$

$$I_f = \frac{V_f}{R_f + R_{adj}}$$

(يستخدم Φ)

* DC - generators types

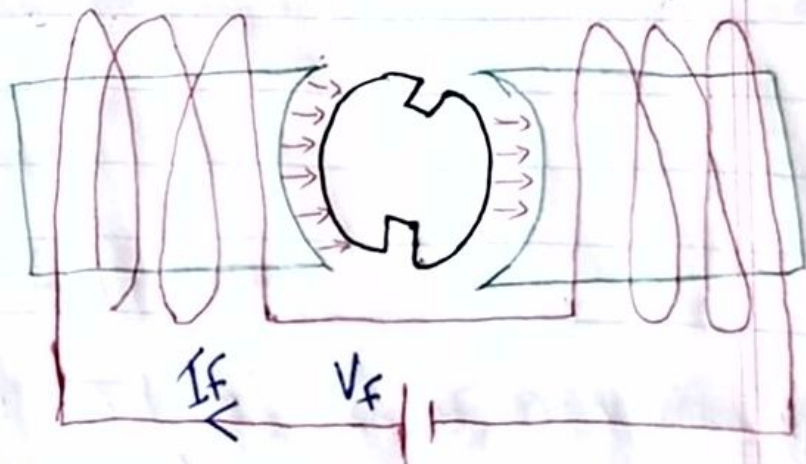
1) separately excited



$$I_f = \frac{V_f}{R_f + R_{adj}}$$

$$E_A = V_T + I_A R_A$$

$$I_L = I_A$$



4) Determine applied torque (Input) for Case (2)
if friction losses = 100 watt

$$P_{\text{input}} = P_{\text{developed}} + P_{\text{friction}}$$

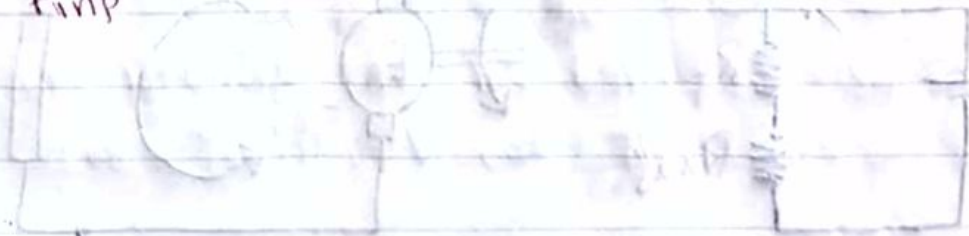
$$= 155 \times 20 + 100 = 3200 \text{ Watt}$$

$$P_{\text{input}} = k \omega = \frac{640 \times 4}{2\pi \times 4} \times \omega = 155$$

$$\omega = 76 \text{ rad/s}$$

$$T_{\text{inp}} = \frac{3200}{76} = 42.1 \text{ Nm}$$

$$\eta = \frac{P_{\text{out}}}{P_{\text{inp}}} = \frac{150 \times 20}{3200} = 93.7\%$$



$$T_{app} = \frac{P_{friction\ losses} + P_{developed}}{\omega}$$

* Sep excited DC generator $\eta = 80\%$, $P_{out} = 6\text{ kW}$
 $V_f = 200\text{ V}$, $I_f = 10\text{ A}$, $n = 1000\text{ rpm}$

Determine applied torque

$$0.8 = \frac{10000}{T \times 1000 \times \frac{2\pi}{60} + 200 \times 10} \Rightarrow T = 100\text{ N.m}$$

* Power flow diagram

$$P_{deve} = E A \times I_A$$

$$V_f \times I_f$$

$$T_{app} \times \omega$$

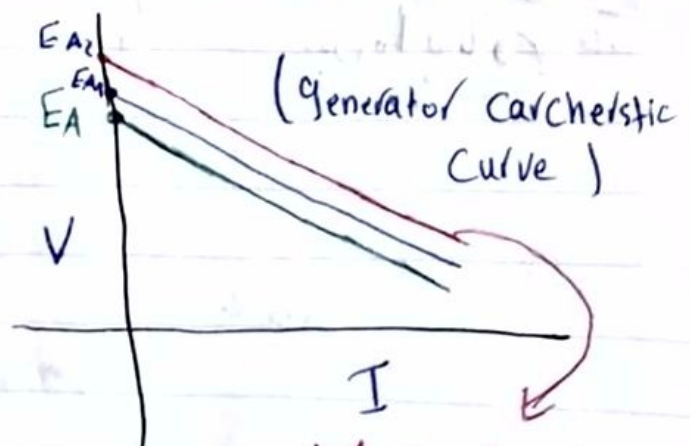
P_{out}
(elect)

non electrical
losses (friction)

elect losses
(elect)

$P_{out} \text{ (electrical)} V \times I$

$$V_T = E_A - I_A R_A$$



$\uparrow \omega \text{ or } \uparrow \omega \text{ or } (\omega \times \omega) \uparrow$

2) Determine R_{adj} required for the generator to supply out put of 20 KW, $V_T = 500$ V, Speed = 1000 rpm.

$$I_L = \frac{20000}{500} = 40 \text{ A}$$

$$E_A = 500 + 40 \times 0.12 = 504.8 \text{ V}$$

504.8 \rightarrow 1000 rpm كل ما زادت السرعة

$E_A \rightarrow$ 800 rpm ينزى E_A

4.8 390

I_f 403.8

6.4 460

$$\frac{4.8 - I_f}{4.8 - 6.4} = \frac{390 - 403.8}{390 - 460}$$

$$I_f = 5.1 \text{ A}$$

$$I_f = \frac{V_f}{R_f + R_{adj}} \Rightarrow 5.1 = \frac{200}{25 + R_{adj}} \Rightarrow R_{adj} = 14.14 \Omega$$

$$P_{inp}(\text{total}) = P_{inp}(\text{mech}) + P_{inp}(\text{elect})$$

$$\eta = \frac{P_{out}}{P_{inp}(\text{total})}$$

$$P_{inp}(\text{mech}) = P_{\text{friction losses}} + P_{\text{developed}}$$

* DC - sep excited generator

EX: DC - sep excited generator, $V_f = 200 \text{ V}$

Armature Resistance $R_A = 0.12 \Omega$, field Resistance $= 25 \Omega$

If	1.6	3.2	4.8	6.4	8.1	9.6	11.2	11.8	A
E _A	148	285	390	460	520	560	590	605	V

1) If the prime mover speed $= 1200 \text{ rpm}$, $R_{adj} = 6 \Omega$
 $R_{load} = 10 \Omega$, determine terminal voltage (V_t) and output power

$$I_f = \frac{200}{25 + 6} = 6.45 \text{ A}$$

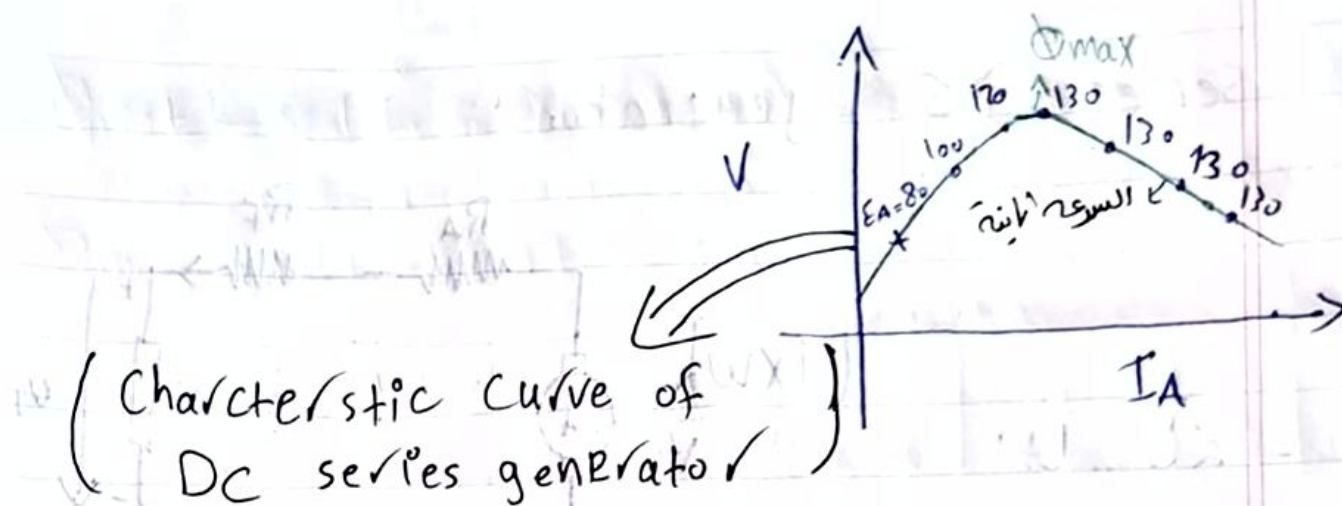
الجدول
نبروت
تقريباً 6.4

$$\begin{array}{ccc} 460 \rightarrow 800 \text{ rpm} & \Rightarrow & E_A = \frac{1200 \times 460}{800} = 690 \text{ V} \\ E_A \rightarrow 1200 & & \end{array}$$

$$I_A = I_L = \frac{E_A}{R_A + R_{load}} = \frac{690}{0.12 + 10} = 68.18 \text{ A}$$

$$P_{output} = (I_L)^2 \times R_{load} = (68.18)^2 (10) = 46,485 \text{ Kwatt}$$

$$T_{ind} = \frac{E_A \times I_A}{\omega} = \frac{P_{out} + I_A^2 R_A}{\omega} = \frac{690 \times 68.18}{1200 \times \frac{2\pi}{60}} = 749 \text{ N.m}$$



Ex 8 DC-series generator $\eta = 90\%$, $P_{inP} = 10 \text{ hp}$
 $V_T = 200 \text{ volt}$, $n = 1000 \text{ rpm}$

Determine developed Power, T_{ind} , $T_{applied}$

$$P_{inP} = 746 \times 10 \text{ watt}$$

$$P_{out} = 0.9 \times 746 \times 10$$

$$V_T = 200$$

$$I_L = \frac{0.9 \times 746 \times 10}{200} = I_f = I_A$$

$$E_A = 200 + I_A \times 1.6 \Rightarrow$$

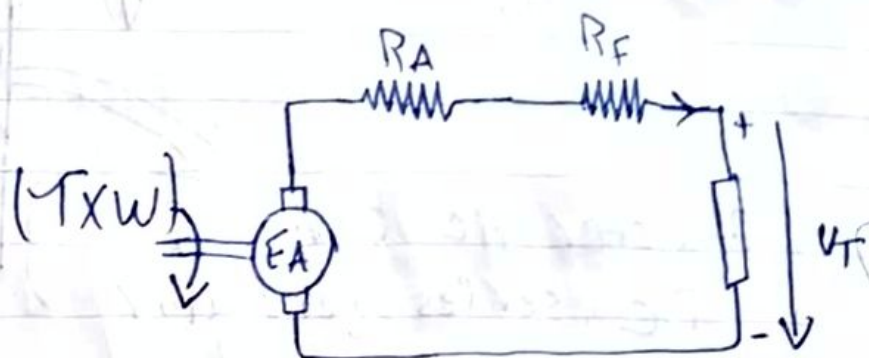
$$1) P_{dev} = E_A \times I_A$$

$$2) T_{ind} = \frac{E_A \times I_A}{\omega} = \frac{E_A \times I_A}{1000 \times \frac{2\pi}{60}}$$

(4) friction losses $P_{inP} - P_{dev}$

$$3) T_{app} = \frac{10 \times 746}{1000 \times \frac{2\pi}{60}}$$

2) series DC generator



$$V_T = E_A - I_A R_A \quad I_A = I_L = I_f$$

$$I_L \uparrow = I_A \uparrow = I_f \uparrow \begin{cases} \Rightarrow \Phi \uparrow \Rightarrow E_A \uparrow \Rightarrow V_T \uparrow \\ \Rightarrow -I_A(R_A + R_f) \uparrow \Rightarrow V_T \downarrow \end{cases}$$

	E_A	I_A	V_T	
	110 V	10 A	100 V	$(R_A + R_f) = 1 \Omega$
50 turns	150 V	15 A	$150 - 15 \times 1 = 135 \text{ V}$	

10 turns	E_A	I_A	V_T
	100 V	10 A	90 V
	105 V	15 A	$105 - 15 \times 1 = 90 \text{ V}$
	108 V	20 A	$108 - 20 \times 1 = 88 \text{ V}$

* Dc - shunt generator with $\eta = 80\%$

$$P_{inP}(\text{mech}) = 5 \text{ kW}, \quad V_T = 100 \text{ V}, \quad R_f + R_{adj} = 100 \, \Omega$$

$$R_A = 0,5 \, \Omega, \quad \text{speed} = 1400 \text{ rpm}$$

1) Determine developed power

$$P_{out} = 5000 \times 0,8 = 4000 \text{ Watt}$$

$$I_L = \frac{4000}{100} = 40 \text{ A}$$

$$I_f = \frac{V_T}{R_f + R_{adj}} = \frac{100}{100} = 1 \text{ A}$$

$$I_A = I_L + I_f = 40 + 1$$

$$P_{dev} = E_A \times I_A$$

$$E_A = 100 + 41 \times 0,5 = 120,5 \text{ V}$$

$$P_{dev} = 120,5 \times 41 = 4940,5$$

$$T_{ind} = \frac{P_{dev}}{\omega} = \frac{4940,5}{1400 \times \frac{2\pi}{60}} = 33,7 \text{ N.m}$$

$$T_{app} = \frac{5000}{1400 \times \frac{2\pi}{60}} = 34,1 \text{ N.m}$$

$$V_T \Rightarrow 220 - 505(,03 + ,004) \Rightarrow 202 \text{ Volt}$$

$$204 \rightarrow V_T \text{ at no load}$$

∴ Under Compound

$$* N_s = ?? \text{ flat}$$

$$I_f = 5 \text{ A}, n = 950 \text{ rpm}, I_L = 500 \text{ A}$$

$$V_T = E_A = 204$$

$$I_f = I_f^*$$

$$204 = E_A - 505(,03 + ,004)$$

$$E_A = 221,1 \rightarrow 950 \text{ rpm} \Rightarrow I_f^* = 9,3$$

$$?? \rightarrow 1000 \text{ rpm} \Rightarrow I_f^* = 9,3$$

نرجع على الجدول 232.7

$$\text{flat} \rightarrow V_{n,L} = V_{f,L}$$

$$I_f^* = 9,3 \text{ A}$$

$$9,3 = 5 + \frac{505 \times W_s}{1200} \Rightarrow N_s = 10,2 \text{ turns}$$